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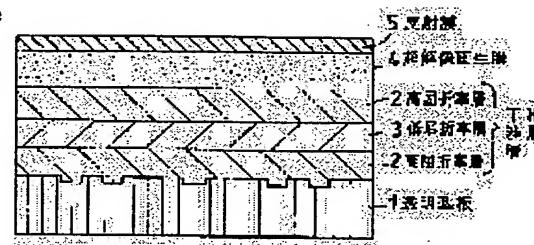
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#### (54) OPTICAL RECORDING MEDIUM

##### (57)Abstract:

**PROBLEM TO BE SOLVED:** To enlarge the difference between the reflection factors of an optical mask part and an optical opening part of an optical recording medium provided with a super-high resolution reproducing film.

**SOLUTION:** In the optical recording medium in which the optical opening part and the optical mask part are formed corresponding to the distribution of the intensity of reproduced light by successively laminating a transparent substrate 1 having a role as a recording layer, a super-high resolution reproducing film 4 whose refractive index is changed corresponding to the intensity of incident light and a reflection film 5 and which reads the recorded information written with a minuter pitch compared with an irradiation light spot, the reproduced light is multiple-reflected in a laminated interference layer 11 and incident light and reflected light are multiple-interfered by inserting the laminated interference layer 11 consisting of a high refractive index layer 2, a low refractive index layer 3 and a high refractive index layer 2 each having an optical film thickness of  $\lambda/4$ , between the super-high resolution reproducing film and the reflection film to enlarge the difference between the reflection factors of the optical recording media in the region (optical opening part) having changed refractive index and in the region (optical mask part) having unchanged refractive index of the super-high resolution reproducing film.



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#### CLAIMS

[Claim(s)]

[Claim 1]A transparent substrate.

A layered product which consists of a super-resolution-reproducing film from which a refractive index changes when a dose of a recording layer and an interference layer which countered this transparent substrate, were provided and were laminated by order arbitrary between a reflecting layer which reflects light irradiated from said transparent substrate side, and said substrate and said reflecting layer, and said light exceeds a predetermined threshold.

Are the above the optical recording medium which it had, and said interference layer, It is characterized by being the lamination interference layer which laminated at least three layers which consist of the 1st high refractive index layer that has a predetermined refractive index, low refractive index layers whose refractive index is lower than these 1st refractive index layers, and the 2nd refractive index layers whose refractive index is higher than this low refractive index layer sequentially from said transparent substrate side.

[Claim 2]A difference of a refractive index in early stages of said super-resolution-reproducing film, and a refractive index when it changes deltan, The optical recording medium according to claim 1 characterized by filling  $\Delta R/d > \Delta n/n > 0.007$  when thickness of  $\Delta R$  ( $0 < R \leq 1$ ) and said super-resolution-reproducing film is set to  $d$  (nm) for a difference of reflectance when a refractive index of said super-resolution-reproducing film changes.

[Claim 3]A transparent substrate which has recorded information.

A layered product which consists of a super-resolution-reproducing film from which a refractive index changes when a dose of an interference layer and said light which countered this transparent substrate, were provided and were laminated by order arbitrary between a reflecting layer which reflects light irradiated from said transparent substrate side, and said substrate and said reflecting layer exceeds a predetermined threshold.

Are the above the optical recording medium which it had, and said interference layer, It is characterized by being the lamination interference layer which laminated at least three layers which consist of the 1st high refractive index layer that has a predetermined refractive index, low refractive index layers whose refractive index is lower than these 1st refractive index layers, and the 2nd refractive index layers whose refractive index is higher than this low refractive index layer sequentially from said transparent substrate side.

[Claim 4]The optical recording medium according to claim 1 having the optical matching layer which controlled a refractive index or thickness to make reflectance of an optical recording medium into the minimum at the time of an optical exposure which adjoins said super-resolution-reproducing film, is provided, and does not exceed said threshold.

[Claim 5]An optical recording medium comprising:

A transparent substrate.

A reflection film which reflects light in which this transparent substrate is countered and it is provided, and which is irradiated from said transparent substrate side.

A super-resolution-reproducing film to which a refractive index is changed when it is formed between said transparent substrate and said reflection film and an optical dose exceeds a predetermined threshold.

A low refractive index layer whose refractive index is lower than a refractive index of said super-resolution-reproducing film when it irradiates with light which is formed in this super-resolution-reproducing membrane surface, and does not exceed said predetermined threshold, A recording layer which was formed in this low refractive index layer surface, and was formed between a high refractive index layer whose refractive index is higher than said low refractive index layer, between said transparent substrate and a super-resolution-reproducing film or said high refractive index layer, and a reflecting layer.

[Claim 6]A reflection film which reflects light in which this transparent substrate is countered the transparent substrate side, and it is provided, and which is irradiated from said transparent substrate side, A super-resolution-reproducing film from which a refractive index changes with

the optical exposures of intensity exceeding a predetermined threshold formed between said substrate and a reflection film, Catoptric light by said reflection film to regenerated light which possesses an interference layer and a recording layer and is irradiated from said transparent substrate side, In an optical recording medium which makes an interference light with catoptric light by said interference layer and said super-resolution-reproducing film catoptric light of an optical recording medium and with which reflected light intensity differs corresponding to a refractive index changing region of said super-resolution-reproducing film, An optical recording medium, wherein said interference layer is a lamination interference layer which laminated a high refractive index layer and a low refractive index layer from which a refractive index differs so that said regenerated light may carry out a multiple echo within a recording medium.

[Claim 7]A reflection film which reflects light in which this transparent substrate is countered the transparent substrate side which has recorded information, and it is provided, and which is irradiated from said transparent substrate side, Catoptric light by said reflection film to regenerated light which possesses a super-resolution-reproducing film from which a refractive index changes, and an interference layer, and is irradiated from said transparent substrate side by optical exposure of intensity exceeding a predetermined threshold formed between said substrate and a reflection film, In an optical recording medium which makes an interference light with catoptric light by said interference layer and said super-resolution-reproducing film catoptric light of an optical recording medium and with which reflected light intensity differs corresponding to a refractive index changing region of said super-resolution-reproducing film, An optical recording medium, wherein said interference layer is a lamination interference layer which laminated a high refractive index layer and a low refractive index layer from which a refractive index differs so that said regenerated light may carry out a multiple echo within a recording medium.

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[Translation done.]

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

#### [0001]

[Field of the Invention]Especially this invention relates to the optical recording medium possessing a super-resolution-reproducing film with respect to an optical recording medium.

#### [0002]

[Description of the Prior Art]Optical disk memory which performs reproduction of information, or record and reproduction by the exposure of an optical beam is put in practical use by various files, such as a sound, a picture, and computer data, as memory storage which has large scale nature, rapid access nature, and medium portability.

The development continues to be expected.

[0003]As densification art of an optical disc, the short wavelength formation of the gas laser for original recording cutting, the short wavelength formation of the semiconductor laser which is a

light source of operation, high-numerical-aperture-izing of an object lens, and sheet metalization of the optical disc are considered. In a recordable optical disc, there are various approaches, such as mark length record and land groove recordings.

[0004]The super resolution art using a medium film is proposed as art in which the effect of the densification of an optical disc is large. although super resolution art was proposed as art peculiar to a magneto-optical disc at the beginning, the trial with which a ROM disk also provides and carries out super resolution reproducing of the super resolution film from which the transmissivity of light changes with the exposures of regenerated light to the regenerated light exposure side to a recording layer is reported after that. Thus, super resolution art was understood that it can apply to all the optical discs, such as a magneto-optical disc, CD-ROM, CD-R, WORM, and a phase change type optical recording medium.

[0005]The super-resolution-reproducing film proposed with the conventional super-resolution-reproducing art is divided roughly into a heat mode method and a photon mode method. By a heat mode method, a super-resolution-reproducing film is made to generate a phase transition etc. with heating by regenerated light exposure, and an optical opening with high transmissivity is formed. The shape of this optical opening becomes the same as that of the constant temperature line of a super-resolution-reproducing film.

[0006]By a photon mode method, coloring or the decolorization by regenerated light exposure is used, using a photochromic material as a super-resolution-reproducing film. An electron excites a photochromic material from a ground level from an optical exposure to a short-life excitation state, and it reveals change of light absorption characteristics by changing to very long-life metastable excitation level, and being further, caught from excitation level. Therefore, it is necessary to carry out deexcitation of the electron caught by metastable excitation level to a ground state for reproducing repeatedly, and to close the once formed optical opening. There is also an example using the semiconductor continuation film or semiconductor particulate dispersion film which used absorption saturation phenomena as a super-resolution-reproducing film of a photon mode method.

[0007]which method -- an imitation -- depending on the grade of change of the optical constant by optical exposure, the characteristic of a super-resolution-reproducing film enlarges the reflectance difference of an optical opening part with high reflectance, and an optical mask part with low reflectance within light spot, so that change of an optical constant is large. However, in order that the variation of an optical constant may be dependent on the material, change of a refractive index is enlarged and there is a limit in enlarging a reflectance difference. When a reflectance difference could not be enlarged and super resolution reproducing is carried out, there is a possibility that the reading failure of recorded information may occur.

[0008]

[Problem(s) to be Solved by the Invention]As mentioned above, when the reflectance difference of an optical mask part and an optical opening part could not be enlarged in the optical recording medium which uses a super-resolution-reproducing film, there was a problem that recorded information was correctly unreplicable.

[0009]This invention is made in view of such a problem, and is a thing.

It is providing the optical recording medium which can reproduce correctly the information which enlarged the reflectance difference of the purpose and an optical mask part, and was recorded with high density.

[0010]

[Means for Solving the Problem]. An optical recording medium of this invention was laminated by order arbitrary between a transparent substrate, a reflecting layer, and said substrate and a reflecting layer. In an optical recording medium to provide, a layered product which consists of a super-resolution-reproducing film from which a refractive index changes when a recording layer, an interference layer, and an optical dose exceed a predetermined threshold said interference layer. It is characterized by being the lamination interference layer which laminated at least three layers which consist of the 1st high refractive index layer that has a predetermined refractive index, low refractive index layers whose refractive index is lower than these 1st refractive index

layers, and the 2nd refractive index layers whose refractive index is higher than this low refractive index layer sequentially from said transparent substrate side.

[0011]That is, the multiple echo of the light irradiated an optical recording medium is carried out, and it is characterized by enlarging change of reflected light intensity corresponding to a refractive index change of a super-resolution-reproducing film by detecting catoptric light which carried out multiple interference within an optical recording medium.

[0012]As for thickness of said 1st [ the ] thru/or the 3rd interference layer, it is preferred to use lambda / about 4 substantially to the wavelength lambda of regenerated light with which an optical recording medium is irradiated.

[0013]When thickness of  $\Delta R$  ( $0 < R \leq 1$ ) and said super-resolution-reproducing film is set [ change of a refractive index when a refractive index of said super-resolution-reproducing film changed ] to  $d$  (nm) for a difference of reflectance of  $\Delta n$  and an optical recording medium, it is desirable to fill  $\Delta R/d \geq \Delta n/n \times 0.007$ .

[0014]That is, it becomes possible to enlarge change of reflected light intensity corresponding to a refractive index change of a super-resolution-reproducing film by enlarging  $\Delta R/d$  more to  $\Delta n/n$ . It is making the number of laminations increase in combination of a high refractive index layer and a low refractive index layer to a \*\*\*\*\* interference layer, and, specifically, it becomes possible to enlarge change of reflected light intensity more.

[0015]Said transparent substrate can serve as said recording layer.

[0016]It is desirable to insert an optical matching layer between said interference layer and a reflecting layer.

[0017]Another recording medium of this invention comprises:

Transparent substrate.

Reflection film.

A super-resolution-reproducing film to which a refractive index is changed when it is formed between said transparent substrate and a reflection film and an optical dose exceeds a predetermined threshold.

A low refractive index layer whose refractive index is lower than a refractive index of said super-resolution-reproducing film when it irradiates with light which is formed in this super-resolution-reproducing membrane surface, and does not exceed said predetermined threshold, A recording layer which was formed in this low refractive index layer surface, and was formed between a high refractive index layer whose refractive index is higher than said low refractive index layer, between said transparent substrate and a super-resolution-reproducing film or said high refractive index layer, and a reflecting layer.

[0018]A reflection film which reflects light in which another optical recording medium of this invention counters this transparent substrate the transparent substrate side, and is formed, and which is irradiated from said transparent substrate side, A super-resolution-reproducing film from which a refractive index changes with the optical exposures of intensity exceeding a predetermined threshold formed between said substrate and a reflection film, Catoptric light by said reflection film to regenerated light which possesses an interference layer and a recording layer and is irradiated from said transparent substrate side, In an optical recording medium which makes an interference light with catoptric light by said interference layer and said super-resolution-reproducing film catoptric light of an optical recording medium and with which reflected light intensity differs corresponding to a refractive index changing region of said super-resolution-reproducing film, Said interference layer is characterized by being the lamination interference layer which laminated a high refractive index layer and a low refractive index layer from which a refractive index differs so that said regenerated light may carry out a multiple echo within a recording medium.

[0019]The transparent substrate side in which another optical recording medium of this invention has recorded information, A reflection film which reflects light in which this transparent substrate is countered and it is provided, and which is irradiated from said transparent substrate side, Catoptric light by said reflection film to regenerated light which possesses a super-resolution-reproducing film from which a refractive index changes, and an interference layer, and

is irradiated from said transparent substrate side by optical exposure of intensity exceeding a predetermined threshold formed between said substrate and a reflection film, In an optical recording medium which makes an interference light with catoptric light by said interference layer and said super-resolution-reproducing film catoptric light of an optical recording medium and with which reflected light intensity differs corresponding to a refractive index changing region of said super-resolution-reproducing film, Said interference layer is characterized by being the lamination interference layer which laminated a high refractive index layer and a low refractive index layer from which a refractive index differs so that said regenerated light may carry out a multiple echo within a recording medium.

[0020]That is, as long as it is the composition which a multiple echo and interference produce within an optical recording medium, a lamination interference layer may be laminated, for example in order of a low refractive index layer, a high refractive index layer, and a low refractive index layer not only in order of a high refractive index layer, a low refractive index layer, and a low refractive index layer.

[0021]Also in these optical recording media, since a multiple echo and catoptric light which carried out multiple interference are detectable, change of reflected light intensity corresponding to a refractive index change of a super-resolution-reproducing film can be enlarged more.

[0022]

[Embodiment of the Invention]Drawing 1 is a sectional view showing an example of the optical recording medium of this invention.

[0023]Recorded information is formed in the transparent substrate 1 which consists of quartz substrates (refractive index 1.45) as a pit. On this transparent substrate, the lamination interference layer 11 to which the plural laminates of the low refractive index layer 3 of optical film thickness  $\lambda / 4$  which consists of the high refractive index layer 2 (refractive index 2.35) and  $MgF_2$  (refractive index 1.4) of optical film thickness  $\lambda / 4$  which consist of ZnS(s).

were carried out is formed. Furthermore on the lamination interference layer 11, the super-resolution-reproducing film 4 and the reflection film 5 are laminated one by one.

[0024]Said refractive index and optical film thickness are against light with a wavelength of 410 nm. Therefore, thickness of the high refractive index layer is set to 43.6 nm and thickness  $\lambda / 70.7$  nm of a low refractive index layer.

[0025]To the light which does not exceed the threshold mentioned later, the refractive index used the thing of 2.0 and the super-resolution-reproducing film set it to the thickness from which the reflectance of an optical recording medium becomes the minimum, and 86.5 nm to the light which does not exceed a threshold.

[0026]In such an optical recording medium, said reflectance of the regenerated light irradiated from the transparent substrate side, By the strength of the interference light of the light reflected by the reflection film and the light which carries out a multiple echo within a lamination interference layer, determine and this invention, It makes it possible to enlarge the S/N ratio of the optical mask and optical opening which are formed with a super-resolution-reproducing film by observing the interference light of the light reflected with the reflection film, and the light which carried out the multiple echo by the lamination interference layer.

[0027]First, the reflectance of a lamination interference layer is explained.

[0028]The sectional view of a lamination interference layer is shown in drawing 2, and the reflectance of a lamination interference layer is shown in drawing 3. However, the refractive index of each class shall be the value mentioned above, and there shall be no wavelength dispersion.

[0029]Drawing 2 is formed from the transparent substrate 1 and the lamination interference layer 11, and the composition is the same as that of what was shown in drawing 1.

[0030]Among drawing 3, R (H) shows reflectance when R (HLHLH) laminates a high refractive index layer and five layers of low refractive index layers by turns, when 1 stratification of the high refractive index layer is carried out on a quartz substrate, and R (HLH) forms three layers, a high refractive index layer, a low refractive index layer, and a high refractive index layer, on a quartz substrate (composition shown by drawing 2).

[0031]In R (H), maximum reflectance is low, and the wavelength area which changes from a high

reflectance belt to a low reflectance belt is large so that drawing 3 may show. On the other hand, in R (HLH) (i.e., when a multiple echo arises between the layers of the high refractive index layer of a couple), the wavelength area which maximum reflectance increases and changes from a high reflectance belt to a low reflectance belt becomes narrow. That is, the steepness of a refractive index change increases. It is so remarkable that the number of laminations of a low refractive index layer and a high refractive index layer increases (i.e., so that the opportunity of this to carry out a multiple echo increases) (about the numerical orientation method of reflectance.). It indicates to "translation Nikkan Kogyo Shimbun" besides Shigetaro Ogura written by optical thin film H.A.Macleod, and "Kozo Ishiguro edited by optical thin film 2nd edition Shiro Fujiwara, Hideo Ikeda and KYORITSU SHUPPAN written by Hideji Yokota."

[0032]The reflection spectrum which changed and calculated the number of laminations of the lamination interference layer of the optical recording medium of the structure shown in drawing 1 was shown in drawing 4. It turns out that the difference of maximum reflectance and the minimum reflectance becomes large, and change is steep as the number of laminations increases. Like drawing 3, cross protection shows up notably and the steepness of this tendency of a reflectance change increases as the number of laminations increases.

[0033]Next, the reflectance of an optical recording medium in case the refractive indices of the super-resolution-reproducing film of drawing 1 differ is shown in drawing 5. As shown in drawing 5, the wavelength from which a refractive index follows on increasing and reflectance serves as the minimum shifts to the long wavelength side.

[0034]For example, when the refractive index of a super resolution re-film changes to 1.8 from 1.7, the reflectance difference of the light near the wavelength of 410 nm changes to about about 0.7.

[0035]This reflectance difference is made so greatly that a reflectance change is steep so that drawing 5 may also show.

[0036]Next, a super-resolution-reproducing film is explained.

[0037]The super-resolution-reproducing film concerning this invention to the light below a predetermined threshold A predetermined refractive index. It has (it is hereafter called an early refractive index), and only the portion with which the light exceeding a predetermined threshold was irradiated is a film formed from the material which changes to a selectively different refractive index (it is hereafter called the refractive index at the time of super resolution reproducing), and, generally the thing of a heat mode system and a photon mode system is known.

[0038]With the super-resolution-reproducing film of a heat mode system, only the portion which exceeds a threshold with heating by optical beam exposure is selectively generated for a phase transition etc., and a refractive index is changed. For example, thermochromic materials, such as phase change materials, such as GeSbTe of a chalcogen system and AgInSbTe, a BIANSURON system, and a spiropyran, etc. are mentioned.

[0039]That for which the super-resolution-reproducing film of a photon mode system used coloring or decolorization, for example by optical exposures, such as a photochromic material, is mentioned. An electron excites a photochromic material from regulation ranking from an optical exposure to a short-life excitation state, and a refractive index is selectively changed by changing to very long-life metastable excitation level, and being further, supplemented from excitation level. Specifically, a PIROBENZO pyran series molecule, a fulgide system molecule, a diaryl ethene system molecule, a cyclophane system molecule, azobenzene, etc. are mentioned. A semiconductor, a semiconductor particulate dispersion film, etc. from which an optical constant changes with absorption saturation are mentioned.

[0040]Although there are what changes to a high refractive index to the light exceeding a threshold, and a thing which changes to a low refractive index in such a super-resolution-reproducing film, the super high resolution reproduction method in the case of the former is explained here.

[0041]The refractive index change of the super-resolution-reproducing film to the intensity of an optical beam is illustrated to the intensity distribution of the optical beam sent to drawing 6 (a) by laser, and (b). (c) shows the top view showing the optical property of an optical recording

medium when this super-resolution-reproducing film is used for the optical recording medium shown in drawing 1.

[0042]Intensity becomes weaker as an optical beam has intensity distribution as generally shown in drawing 6 (a), and it separates from the center of a beam. A super-resolution-reproducing film changes a refractive index from the early refractive index  $n$  to  $n_1$  to the optical beam exceeding a threshold. Here, when the wavelength of  $n=1.7$ ,  $n=1.8$ , and an optical beam is 410 nm, as shown in drawing 5, in the position of the refractive index 1.7, reflectance will be about 2%, and reflectance will be about 70% in the position of the refractive index 1.8.

[0043]Therefore, as shown in drawing 6 (c), only the field where the refractive index changed reflects light also in light spot S. In the position of an early refractive index, light is not reflected, i.e., an optical opening part is formed, only the light irradiating part exceeding a threshold detects the recorded information on the range corresponding to this optical opening part, an optical mask part is formed in the light irradiating part below a threshold, and the recorded information on the range corresponding to this optical mask is not detected. Therefore, a light spot S twist also makes possible reading of recorded information, i.e., super resolution reproducing, with a narrow pitch.

[0044]Adjustment of the value of the optical recording medium at the time of an early refractive index adjoins a super-resolution-reproducing film, can form an optical matching layer, and not only the method of controlling the thickness of a super-resolution-reproducing film but can adjust the refractive index and thickness of a matching layer according to the early refractive index and thickness of a super-resolution-reproducing film.

[0045]Although drawing 5 explained the case where the refractive index in early stages of a super-resolution-reproducing film was 1.7, the case where an early refractive index is 2.3 similarly is examined.

[0046]The optical recording medium in which the characteristic of drawing 5 is shown except for the early refractive index having set the thickness to 73.5 nm, using the thing of 2.3 as a super-resolution-reproducing film so that the reflectance of an optical recording medium might serve as the minimum on the regenerated light wavelength of 410 nm, and the optical recording medium of the same composition were used.

[0047]In such an optical recording medium, the reflectance of the optical recording medium in the case of changing with the lights in which the refractive index of a super-resolution-reproducing film exceeds a threshold to 2.32, 2.35, or 2.4 is shown in drawing 7, and a reflectance difference is shown in drawing 8.

[0048]Even if a refractive index change is as small as 0.02, the reflectance difference of an optical opening and an optical mask is over 10%.

[0049]As drawing 8 shows, that the variation of reflectance serves as the maximum is the wavelength which shifted for a while from 410 nm. Therefore, in order to actually make a reflectance difference into the maximum with a reproducing wave length, it is desirable to adjust a super-resolution-reproducing film and to make it the reflectance of an optical recording medium become the minimum at the time of an early refractive index.

[0050]Adjustment of the reflectance of the optical recording medium at the time of an early refractive index adjoins a super-resolution-reproducing film, can form an optical matching layer, and not only the method of controlling the thickness of a super-resolution-reproducing film but can adjust the refractive index and thickness of a matching layer according to the early refractive index and thickness of a super-resolution-reproducing film.

[0051]Variation  $\Delta n$  ( $n-n_1$ ) of the refractive index  $n_1$  to the refractive index  $n$  in early stages of a super-resolution-reproducing film which changed comparatively these results on a horizontal axis  $\Delta n/n$ , Thickness of a super-resolution-reproducing film is set to  $d$ , the case where \*\* and a lamination interference layer are not provided [ the early refractive index 1.7 and the time ] for O and the time of 2.3 in a vertical axis as reflectance difference  $\Delta R/d$  per unit membrane thickness ( $nm^{-1}$ ) is made into  $x$ , and it is shown in drawing 9.

[0052]When filling the relation which becomes  $\Delta R/d > \Delta n/n \times 0.007$  and a lamination interference layer is adjusted, it turns out that the effect of this invention becomes remarkable. That is, it is necessary to adjust a lamination interference layer so that the relation mentioned

above according to the refractive index variation of a super-resolution-reproducing curtain may be filled. Specifically, deltaR can be adjusted with each refractive index and number of laminations of a high refractive index layer and a low refractive index layer. For example, if the combination of a low refractive index layer and a high refractive index layer is changed, as shown in drawing 10, maximum reflectance and the minimum reflectance will change.

[0053]There is a tendency for the maximum reflectance of an optical recording medium to be so high that the refractive index difference of a low refractive index layer and a high refractive index layer be large, for the minimum reflectance to become low, and for a reflectance difference to become large. The relation between reflectance difference  $R_{max}-R_{min}$  and  $\delta R/d$  was shown in drawing 11 as the maximum reflectance  $R_{max}$  and the minimum reflectance  $R_{min}$ . In drawing 11, also when the lamination interference layer is not arranged, it writes together.

[0054] $\delta R/d$  increases rapidly in  $R_{max}-R_{min}>0.2$  and the effect of providing a lamination interference layer becomes remarkable so that drawing 11 may show. Therefore, it is preferred to fill the relation which becomes  $\delta R/d > \delta n/nx0.007$  as a lamination interference layer, and to fill  $R_{max}-R_{min}>0.2$ .

[0055]Although the refractive index mentioned above referred to the real part of the complex index of refraction and the extinction coefficient of the imaginary part was explained as 0, the case where the extinction coefficient of a super-resolution-reproducing film is not 0 is described. The optical recording medium of the same composition as drawing 1 shows the reflectance of an optical recording medium in case the refractive index of a super-resolution-reproducing film is 2.3 and an extinction coefficient is 0, 0.1, 0.2, 0.5, or 1 to drawing 12. However, the thickness of the super-resolution-reproducing film could be 73.5 nm.

[0056]the maximum reflectance  $R_{max}$  becomes low as an extinction coefficient becomes large so that drawing 12 may show, and the minimum reflectance  $R_{min}$  becomes high --  $R_{max}-R_{min}$  becomes small. Change of the reflectance from a high reflection region to a low reflection field becomes slow. For this reason, even if a refractive index changes in this situation, the reflectance differences of an optical opening and an optical mask will be few, and sufficient effect will not be acquired. Therefore, if it is a range with which  $R_{max}-R_{min}>0.2$  is filled, even if a super-resolution-reproducing film has a limited extinction coefficient, it can acquire the effect of a laminated structure.

[0057]Especially as for this invention, to change of an extinction coefficient, when large, the effect is acquired for a refractive index change. In this case, since the reflectance change by the wavelength used as the minimum reflectance shifting becomes dominant, the reflectance difference a refractive-index front and after change can choose positive/negative freely by setting out of the wavelength used as the minimum reflectance.

[0058]Although the high refractive index layer or low refractive index layer used for a lamination interference layer had the respectively same refractive index in above-mentioned explanation, the high refractive index layer concerning this invention or a low refractive index layer should be [ that a relative refractive index is high to \*\*\*\*\* refractive index layers, or ] just low. Namely, incident light should just fill the composition of a lamination interference layer which carries out a multiple echo between the 1st high refractive index layer and the 2nd refractive index layers.

[0059]If conditions which were mentioned above are fulfilled, the laminating order of a lamination interference layer, a recording layer, and a super-resolution-reproducing film can be designed arbitrarily.

[0060]Although the pit was formed in the transparent substrate and the transparent substrate and the recording layer were made to serve a double purpose in drawing 1, the recording layer concerning this invention can also consider the recording layer in which the field where optical properties differ it is not limited to this and respond up to picture information was formed as the composition laminated separately.

[0061]The high refractive index layer which adjoins the super-resolution-reproducing film shown in drawing 1 is ommissible by using the material of a high refractive index as a super-resolution-reproducing film. That is, since the multiple echo and multiple interference of light will arise between a super-resolution-reproducing film and a high refractive index layer if the refractive index in early stages of a super-resolution-reproducing film is larger than the refractive index of

a low refractive index layer, the same effect as the optical recording medium shown by drawing 1 is acquired.

[0062]

[Example] Hereafter, the example of this invention is described with reference to drawings.

[0063] In example 1 this example, the optical recording medium of the laminated structure of low refractive index layer / transparent substrate / [high refractive index layer] x 3-/super resolution film / reflection film was used. A low refractive index layer / [high refractive index layer] x 3 are the lamination interference layers by which a low refractive index layer and 3 sets of high refractive index layers were laminated.

[0064] Each layer was adjusted as follows so that super resolution reproducing could be performed, when regenerated light was the wavelength of 413 nm.

[0065] The pit (0.2 micrometer – 0.6 micrometer) formed in this PC board according to the track, respectively, using a polycarbonate (PC) board as a transparent substrate.

[0066] Thickness was taken as the thickness, 68.3 nm of low refractive index layers, and 42.7 nm of high refractive index layers by which optical film thickness is equivalent to  $\lambda/4$  at the low refractive index layer and the high refractive index layer using  $\text{SiO}_2$  (refractive index: 1.5) and  $\text{ZnS}$  (refractive index: 2.4).

[0067] Refractive index: Using the super-resolution-reproducing film of 0, the thickness set 2.3 and an extinction coefficient to 73.5 nm so that the reflectance of an optical recording medium might serve as the minimum in the initial state with which regenerated light is not irradiated. If regenerated light is irradiated with this super-resolution-reproducing film, a refractive index will change to 2.4 only the central part of light spot.

[0068] The thickness is 50 nm, using  $\text{AlTi}$  in a reflection film.

[0069] Except that there was no comparative example 1 lamination interference layer, the disk of the same composition as this example was produced.

[0070] The pit length dependency of CNR (Carrier to Noise Ratio) was measured by the playback evaluator which used Kr+ gas laser as the light source for the disk of Example 1 and the comparative example 1. They are a reproducing wave length of 413 nm, and 1 mW of reproduction power.

[0071] The result was shown in drawing 13. When pit length is as long as 0.4 micrometers or more, the comparative example of CNR without a super-resolution-reproducing film is larger but so that drawing 13 may show, and if pit length becomes shorter than 0.4 micrometer, CNR will decrease rapidly. This is because sufficient super resolution effect is not acquired. On the other hand, the disk of this example is maintaining high CNR, even if pit length becomes short with 0.2 micrometer. From the above thing, it has checked that a multilayer dielectric had an effect in the improvement in the characteristic of a super-resolution-reproducing film.

[0072] In example 2 this example, the optical recording medium of the laminated structure of low refractive index layer / transparent substrate / [high refractive index layer] x 2-/low refractive index layer / super resolution film / matching layer / reflection film was used. A low refractive index layer / [high refractive index layer] x 2 are the lamination interference layers by which a low refractive index layer and 2 sets of high refractive index layers were laminated.

[0073] Regenerated light used laser with a wavelength of 413 nm like Example 1.

[0074] About the transparent substrate, the low refractive index layer, the high refractive index layer, and the reflection film, it was considered as the same conditions as Examples 1, such as construction material and thickness.

[0075] The material of the same refractive index as Example 1 was used for the super-resolution-reproducing film. In this example, optical film thickness made thickness of the super-resolution-reproducing film the thickness equivalent to  $\lambda/4$ , i.e., 44.9 nm.

[0076]  $\text{AlN}$  was used for the matching layer. The refractive index of  $\text{AlN}$  is 1.8. The thickness of the matching layer has been 100 nm so that reflectance may serve as the minimum in the initial state with which regenerated light is not irradiated. The thickness is 50 nm, using  $\text{AlTi}$  in a reflection film.

[0077] The same measurement as Example 1 was performed, and the same effect as Example 1 was checked.

The lamination of example 3 this example is the same lamination as Example 1. However, the refractive index used 2.2 and the extinction coefficient used the super-resolution-reproducing film of 0.4. As for this super-resolution-reproducing film, in a refractive index, 2.15 and an extinction coefficient change [ the spot central part of regenerated light ] with the exposures of regenerated light to 0.05.

[0078]The same measurement as Example 1 was performed, and the same effect was checked.

[0079]In example 4 this example, the optical recording medium of the laminated structure of a transparent substrate / low refractive index layer / [high refractive index layer] x3-/super-resolution-reproducing film / matching layer / recording layer / protective layer / reflecting layer was used.

[0080]Each layer was adjusted as follows so that super resolution reproducing could be performed, when regenerated light was the wavelength of 413 nm.

[0081]It is made to be the same as that of Example 2 about a high refractive index layer, a low refractive index layer, a super-resolution-reproducing film, a matching layer, and a reflection film. The phase change die materials of 20 nm of thickness which becomes a transparent substrate from germanium<sub>2</sub>Sb<sub>2</sub>Te<sub>5</sub> without forming a record pit were separately provided as a recording layer, and it formed the ZnS-SiO two-layer of 40 nm of thickness as a protective layer.

[0082]Except for the point which does not form a high refractive index layer and a low refractive index layer for a comparative example 2 lamination interference layer, the same optical recording medium as Example 4 was created.

[0083]Record and reproduction were performed to the optical recording medium obtained by Example 4 and the comparative example 2 in the following ways.

[0084]413-nm laser performed the recording/reproduction wavelength and it reproduced by scanning and recording this laser by 6 m/s. Recording light set to 9 mW, and it recorded 0.3 micrometer of mark length's recording mark with single frequency, changing a mark interval.

[0085]Reproduction of this recorded information was set as 1 mW of reproduction power, and was performed. The result is shown in drawing 14.

[0086]When a mark interval is 0.3 micrometer or less so that drawing 14 may show, since the influence of intersymbol interference is strong, CNR is falling with the optical recording medium of the comparative example 2. Since the cross talk from an adjacent track is also large, the value of CNR does not become large even when the mark interval on a track is long.

[0087]On the other hand, in the optical recording medium of Example 4, at least 0.15 micrometer of mark intervals can be reproduced by high CNR. Since it is not influenced by a cross talk, the mark interval has been made also in the field over 0.3 micrometer more greatly [ optical recording medium / of the comparative example 2 ] than CNR.

[0088]

[Effect of the Invention]Since the rate difference of a light reflex of the optical mask part and optical opening part of the optical recording medium which has a super-resolution-reproducing film can be enlarged according to this invention as mentioned above, it becomes possible to reproduce the recording mark of a \*\* mark pitch and a narrow track pitch by a high resolution.

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[Translation done.]

\* NOTICES \*

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.\*\*\*\* shows the word which can not be translated.

3.In the drawings, any words are not translated.

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## DESCRIPTION OF DRAWINGS

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**[Brief Description of the Drawings]**

**[Drawing 1]**The sectional view showing an example of the optical recording medium of this invention.

**[Drawing 2]**The sectional view of a lamination interference layer.

**[Drawing 3]**Reflectance of a lamination interference layer.

**[Drawing 4]**The figure showing the reflectance of an optical recording medium when the number of laminations of a lamination interference layer changes.

**[Drawing 5]**The figure showing the reflectance change of an optical recording medium when the refractive index of the super-resolution-reproducing film of drawing 1 changes.

**[Drawing 6]**The refractive index change of a super-resolution-reproducing film [ as opposed to / as opposed to / in (a) / the intensity distribution of an optical beam / the intensity of an optical beam in (b) ] and (c) show the top view showing the optical property of an optical recording medium when this super-resolution-reproducing film is used for an optical recording medium.

**[Drawing 7]**The figure showing the reflectance change of the optical recording medium in the optical recording medium of another embodiment of this invention.

**[Drawing 8]**The figure showing the reflectance difference searched for from the reflectance change shown in drawing 6.

**[Drawing 9]**The figure showing the refractive index variation of a super-resolution-reproducing film, and the relation of the reflectance difference per thickness.

**[Drawing 10]**The figure showing change of the maximum reflectance by the difference in the refractive index of the layer which constitutes a lamination interference layer, and the minimum reflectance.

**[Drawing 11]**The figure showing the relation between the refractive index change of a super-resolution-reproducing film and thickness, and maximum reflectance and the minimum reflectance.

**[Drawing 12]**The figure showing the reflectance of an optical recording medium in case an extinction coefficient is not 0.

**[Drawing 13]**The figure showing the pit length dependency of CNR in the optical recording medium in this example 1.

**[Drawing 14]**The figure showing the mark length dependency of CNR in the optical recording medium of this example 4.

**[Description of Notations]**

1 -- Transparent substrate

2 -- High refractive index layer

3 -- Low refractive index layer

4 -- Super-resolution-reproducing film

5 -- Reflection film

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[Translation done.]

**\* NOTICES \***

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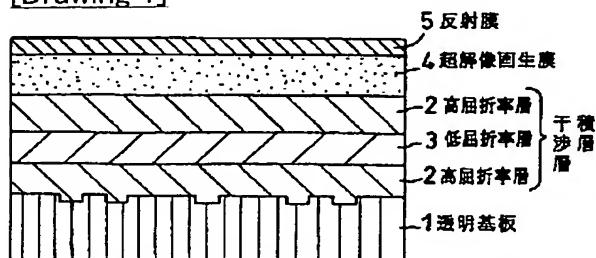
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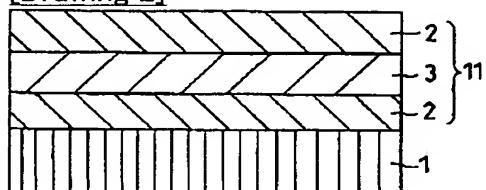
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## DRAWINGS

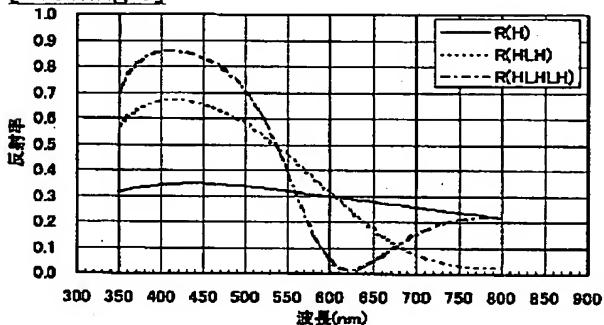
[Drawing 1]



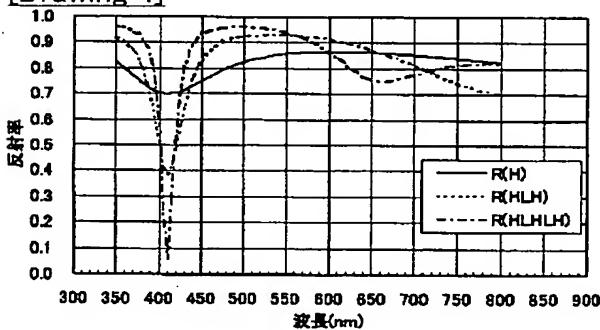
[Drawing 2]



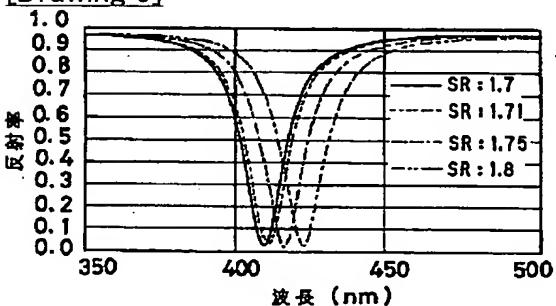
[Drawing 3]



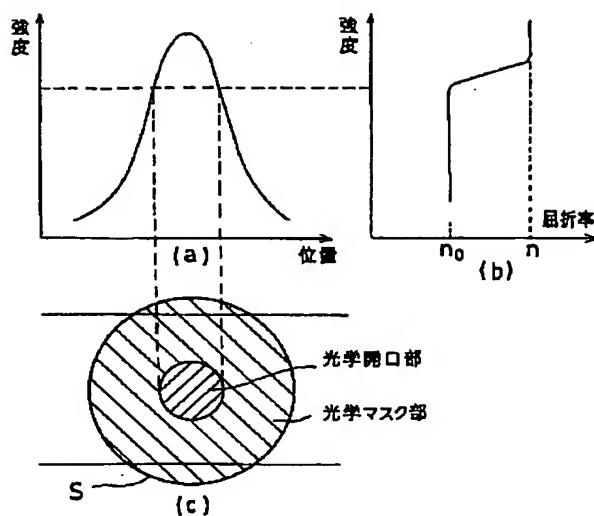
[Drawing 4]



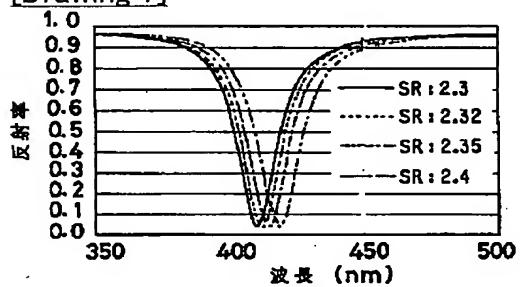
[Drawing 5]



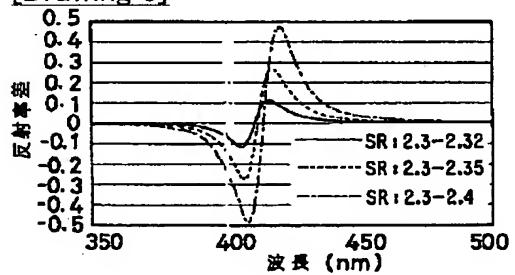
[Drawing 6]



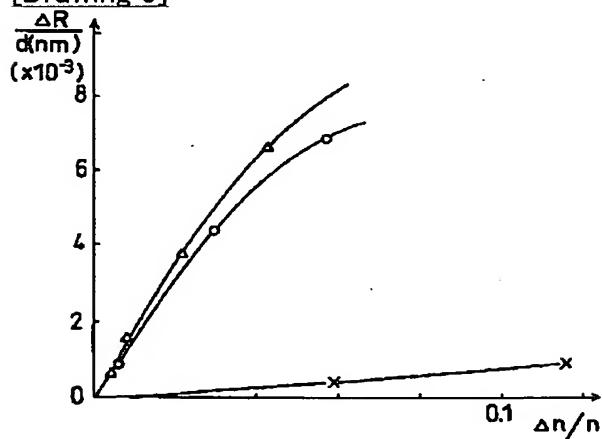
[Drawing 7]



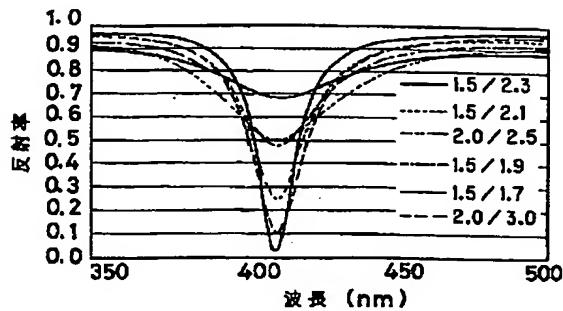
[Drawing 8]



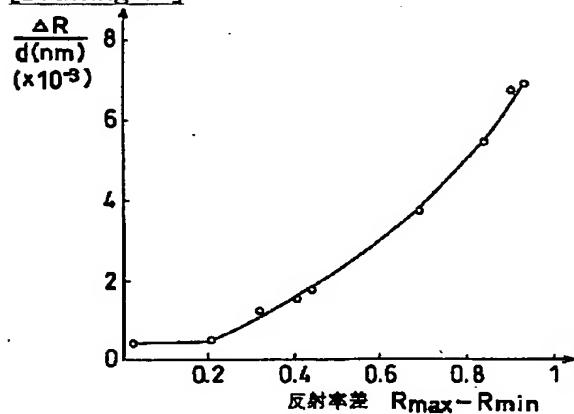
[Drawing 9]



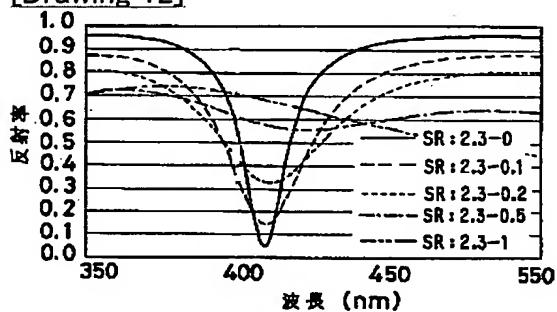
[Drawing 10]



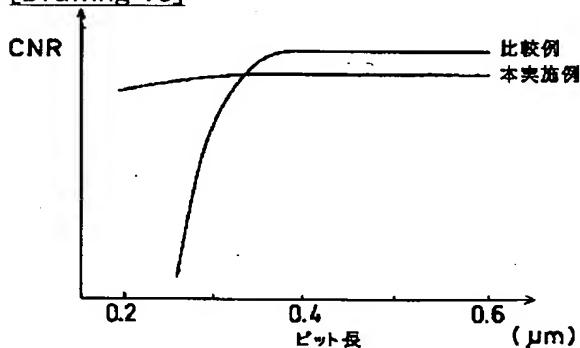
[Drawing 11]

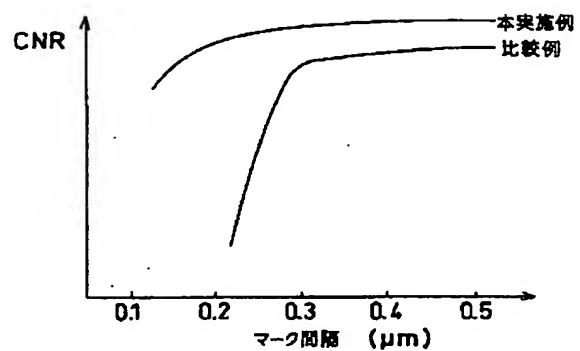


[Drawing 12]



[Drawing 14]





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[Translation done.]

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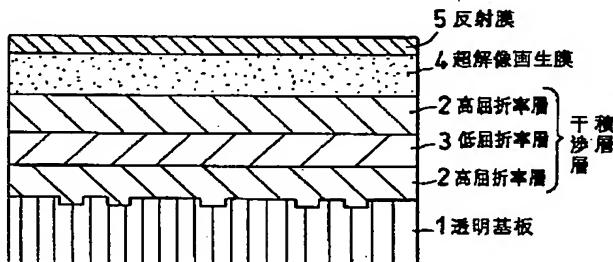
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(54)【発明の名称】光記録媒体

(57)【要約】

【課題】超解像再生膜を具備する光記録媒体の光学マスク部と、光学開口部の反射率差を大きくする。

【解決手段】記録層を兼ねた透明基板1、入射光強度により屈折率が変化する超解像再生膜4と反射膜5とを順次積層したこと、再生光の強度分布に応じて光学開口と光学マスクとが形成され、照射される光スポットよりも微小ピッチで書き込まれた記録情報を読取る光記録媒体において、超解像再生膜と反射膜との間に、それぞれ光学膜厚 $\lambda/4$ の高屈折率層2、低屈折率層3および高屈折率層2からなる積層干渉層11を挿入することで、積層干渉層内で再生光が多重反射し、入射光および反射光とが多重干渉し、超解像再生膜の屈折率が変化した領域(光学開口)と変化しない領域(光学マスク)における光記録媒体の反射率差を大きくする。



## 【特許請求の範囲】

【請求項1】透明基板と、

この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射層と、

前記基板及び前記反射層との間に任意の順に積層された、記録層、干渉層および前記光の照射量が所定の閾値を超えた時に屈折率が変化する超解像再生膜からなる積層体とを具備する光記録媒体において、

前記干渉層は、前記透明基板側から順に、所定の屈折率を有する第1の高屈折率層と、この第1の屈折率層よりも屈折率の低い低屈折率層と、この低屈折率層よりも屈折率の高い第2の屈折率層とからなる少なくとも3層を積層した積層干渉層であることを特徴とする光記録媒体。

【請求項2】前記超解像再生膜の初期の屈折率および変化した時の屈折率の差を $\Delta n$ 、前記超解像再生膜の屈折率が変化した時の反射率の差を $\Delta R$  ( $0 < R \leq 1$ )、前記超解像再生膜の膜厚を $d$  (nm)とした時、

$$\Delta R/d > \Delta n/n > 0.007$$

を満たすことを特徴とする請求項1記載の光記録媒体。

【請求項3】記録情報を有する透明基板と、

この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射層と、

前記基板及び前記反射層との間に任意の順に積層された、干渉層および前記光の照射量が所定の閾値を超えた時に屈折率が変化する超解像再生膜からなる積層体とを具備する光記録媒体において、

前記干渉層は、前記透明基板側から順に、所定の屈折率を有する第1の高屈折率層と、この第1の屈折率層よりも屈折率の低い低屈折率層と、この低屈折率層よりも屈折率の高い第2の屈折率層とからなる少なくとも3層を積層した積層干渉層であることを特徴とする光記録媒体。

【請求項4】前記超解像再生膜に隣接して設けられ、前記閾値を超えない光照射時に光記録媒体の反射率を最低とするように屈折率あるいは膜厚を制御した光学的マッチング層を有することを特徴とする請求項1記載の光記録媒体。

【請求項5】透明基板と、

この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射膜と、

前記透明基板および前記反射膜間に形成され、光照射量が所定の閾値を超えた時に屈折率を変化させる超解像再生膜と、

この超解像再生膜表面に形成され、前記所定の閾値を超えない光を照射した時の前記超解像再生膜の屈折率よりも屈折率の低い低屈折率層と、

この低屈折率層表面に形成され、前記低屈折率層よりも屈折率の高い高屈折率層と、

前記透明基板および超解像再生膜間、又は前記高屈折率

層および反射層間に形成された記録層とからなることを特徴とする光記録媒体。

【請求項6】透明基板側と、この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射膜と、前記基板および反射膜との間に形成された、所定の閾値を超える強度の光照射によって屈折率が変化する超解像再生膜、干渉層、および記録層とを具備し、前記透明基板側から照射される再生光に対する前記反射膜による反射光と、前記干渉層および前記超解像再生膜による反射光との干渉光を光記録媒体の反射光とし、前記超解像再生膜の屈折率変化領域に対応して反射光強度が異なる光記録媒体において、

前記干渉層は、記録媒体内で前記再生光が多重反射するように屈折率の異なる高屈折率層および低屈折率層を積層した積層干渉層であることを特徴とする光記録媒体。

【請求項7】記録情報を有する透明基板側と、この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射膜と、前記基板および反射膜との間に形成された、所定の閾値を超える強度の光照射によって屈折率が変化する超解像再生膜、および干渉層とを具備し、

前記透明基板側から照射される再生光に対する前記反射膜による反射光と、前記干渉層および前記超解像再生膜による反射光との干渉光を光記録媒体の反射光とし、前記超解像再生膜の屈折率変化領域に対応して反射光強度が異なる光記録媒体において、

前記干渉層は、記録媒体内で前記再生光が多重反射するように屈折率の異なる高屈折率層および低屈折率層を積層した積層干渉層であることを特徴とする光記録媒体。

## 30 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明は光記録媒体に係わり、特に超解像再生膜を具備する光記録媒体に関する。

## 【0002】

【従来の技術】光ビームの照射により情報の再生または記録・再生を行う光ディスクメモリは、大容量性、高速アクセス性、媒体可搬性を兼ね備えた記憶装置として音声、画像、計算機データなど各種ファイルに実用化されており、今後もその発展が期待されている。

40 【0003】光ディスクの高密度化技術としては原盤カッティング用ガスレーザーの短波長化、動作光源である半導体レーザーの短波長化、対物レンズの高開口数化、光ディスクの薄板化が考えられている。さらに、記録可能な光ディスクにおいてはマーク長記録、ランド・グループ記録など種々のアプローチがある。

【0004】また、光ディスクの高密度化の効果が大きい技術として、媒体膜を利用した超解像技術が提案されている。超解像技術は当初、光磁気ディスクに特有の技術として提案されていたが、その後、ROMディスクでも記録層に対して再生光照射側に、再生光の照射により

光の透過率が変化する超解像膜を設けて超解像再生する試みが報告されている。このように、超解像技術は光磁気ディスク、CD-ROM、CD-R、WORM、相変化型光記録媒体など全ての光ディスクに適用可能であることが分かった。

【0005】従来の超解像再生技術で提案されている超解像再生膜はヒートモード方式とフォトンモード方式に大別される。ヒートモード方式では再生光照射による加熱で超解像再生膜に相転移などを発生させ、透過率の高い光学開口を形成する。この光学開口の形状は超解像再生膜の等温線と同一になる。

【0006】フォトンモード方式では超解像再生膜としてフォトクロミック材料を用い、再生光照射による発色または消色を利用する。フォトクロミック材料は光照射より電子が基底準位から寿命の短い励起状態へ励起し、さらに励起準位から寿命の非常に長い準安定励起準位へ遷移して捕捉されることにより光吸収特性の変化を発現する。したがって、繰り返して再生するには準安定励起準位に捕捉された電子を基底状態へ脱励起して、いったん形成された光学開口を閉じる必要がある。また、フォトンモード方式の超解像再生膜として吸収飽和現象を利用した半導体連続膜あるいは半導体微粒子分散膜を用いた例もある。

【0007】いずれの方式にせよ、超解像再生膜の特性は光照射による光学定数の変化の程度に依存し、光学定数の変化が大きいほど光スポット内で反射率の高い光学開口部と反射率の低い光学マスク部の反射率差を大きくする。ところが光学定数の変化量はその材料に依存するため、屈折率の変化を大きくして反射率差を大きくするには限界がある。反射率差を大きくできないと、超解像再生した際に、記録情報の読み取り不良が発生する恐れがある。

【0008】

【発明が解決しようとする課題】上述したように、超解像再生膜を使用した光記録媒体においては、光学マスク部と光学開口部との反射率差を大きくできないと、正しく記録情報を再生できないという問題があった。

【0009】本発明は、このような問題に鑑みてなされたものであり、光学開口部と光学マスク部の反射率差を大きくし、高密度に記録された情報を正確に再生できる光記録媒体を提供することを目的とする。

【0010】

【課題を解決するための手段】本発明の光記録媒体は、透明基板と、反射層と、前記基板及び反射層との間に任意の順に積層された、記録層、干渉層および光照射量が所定の閾値を超えた時に屈折率が変化する超解像再生膜からなる積層体とを具備する光記録媒体において、前記干渉層は、前記透明基板側から順に、所定の屈折率を有する第1の高屈折率層と、この第1の屈折率層よりも屈折率の低い低屈折率層と、この低屈折率層よりも屈折率

の高い第2の屈折率層とからなる少なくとも3層を積層した積層干渉層であることを特徴とする。

【0011】すなわち、光記録媒体に照射した光を多重反射させ、光記録媒体内で多重干渉した反射光を検出すことで、超解像再生膜の屈折率変化に対応する反射光強度の変化を大きくすることを特徴としている。

【0012】前記第1乃至第3の干渉層の膜厚は、光記録媒体に照射する再生光の波長 $\lambda$ に対して、実質的に入／出程度にすることが好ましい。

10 【0013】また、前記超解像再生膜の屈折率が変化したときの、屈折率の変化を $\Delta n$ 、光記録媒体の反射率の差を $\Delta R$  ( $0 < R \leq 1$ )、前記超解像再生膜の膜厚を $d$  (nm)とした時、 $\Delta R/d > \Delta n/n \times 0.007$  を満たすことが望ましい。

【0014】すなわち、 $\Delta R/d$  を $\Delta n/n$  に対してより大きくすることで、超解像再生膜の屈折率変化に対応する反射光強度の変化を大きくすることが可能になる。具体的には、隣合う干渉層に対して高屈折率層、低屈折率層の組合せで積層数を増加させることで、より反射光強度の変化を大きくすることが可能となる。

20 【0015】また、前記透明基板は、前記記録層を兼ねることができる。

【0016】また、前記干渉層と反射層との間に光学的なマッチング層を挿入することが望ましい。

【0017】また、本発明の別の記録媒体は、透明基板と、反射膜と、前記透明基板および反射膜間に形成され、光照射量が所定の閾値を超えた時に屈折率を変化させる超解像再生膜と、この超解像再生膜表面に形成され、前記所定の閾値を超えない光を照射した時の前記超解像再生膜の屈折率よりも屈折率の低い低屈折率層と、この低屈折率層表面に形成され、前記低屈折率層よりも屈折率の高い高屈折率層と、前記透明基板および超解像再生膜間、又は前記高屈折率層および反射層間に形成された記録層とからなることを特徴とする。

【0018】本発明の、さらに別の光記録媒体は、透明基板側と、この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射膜と、前記基板および反射膜との間に形成された、所定の閾値を超える強度の光照射によって屈折率が変化する超解像再生膜、40 干渉層、および記録層とを具備し、前記透明基板側から照射される再生光に対する前記反射膜による反射光と、前記干渉層および前記超解像再生膜による反射光との干渉光を光記録媒体の反射光とし、前記超解像再生膜の屈折率変化領域に対応して反射光強度が異なる光記録媒体において、前記干渉層は、記録媒体内で前記再生光が多重反射するように屈折率の異なる高屈折率層および低屈折率層を積層した積層干渉層であることを特徴とする。

【0019】また、本発明の別の光記録媒体は、記録情報を有する透明基板側と、この透明基板に対向して設けられ、前記透明基板側から照射される光を反射する反射

膜と、前記基板および反射膜との間に形成された、所定の閾値を超える強度の光照射によって屈折率が変化する超解像再生膜、および干渉層とを具備し、前記透明基板側から照射される再生光に対する前記反射膜による反射光と、前記干渉層および前記超解像再生膜による反射光との干渉光を光記録媒体の反射光とし、前記超解像再生膜の屈折率変化領域に対応して反射光強度が異なる光記録媒体において、前記干渉層は、記録媒体内で前記再生光が多重反射するように屈折率の異なる高屈折率層および低屈折率層を積層した積層干渉層であることを特徴とする。

【0020】すなわち、光記録媒体内で多重反射・干渉が生じさせる構成であれば、積層干渉層は、高屈折率層、低屈折率層、低屈折率層の順に限らず、例えば低屈折率層、高屈折率層、低屈折率層の順に積層されたものであっても構わない。

【0021】これらの光記録媒体においても、多重反射・多重干渉した反射光を検出できるため、超解像再生膜の屈折率変化に対応する反射光強度の変化をより大きくすることができます。

#### 【0022】

【発明の実施の形態】図1は、本発明の光記録媒体の一例を示す断面図である。

【0023】石英基板（屈折率1.45）からなる透明基板1には、記録情報がピットとして形成されている。この透明基板上には、ZnSからなる光学膜厚入/4の高屈折率層2（屈折率2.35）、およびMgF<sub>2</sub>（屈折率1.4）からなる光学膜厚入/4の低屈折率層3とが複数積層された積層干渉層11が形成されている。さらに積層干渉層11上には、超解像再生膜4及び反射膜5が順次積層されている。

【0024】なお、前記屈折率および光学膜厚は、波長410nmの光に対するものである。したがって、高屈折率層の膜厚は、43.6nm、低屈折率層の膜厚h a 70.7nmとしてある。

【0025】また、超解像再生膜は、後述する閾値を超えない光に対して屈折率が2.0のものを使用し、閾値を超えない光に対して、光記録媒体の反射率が最小になる膜厚、86.5nmとした。

【0026】このような光記録媒体において、透明基板側から照射される再生光の前記反射率は、反射膜によって反射される光と、積層干渉層内で多重反射する光の干渉光の強さによって決定し、本発明は、反射膜によって反射した光と積層干渉層によって多重反射した光の干渉光を観測することで、超解像再生膜によって形成される光学マスクと光学開口とのS/N比を大きくすることを可能にしたものである。

【0027】まず、積層干渉層の反射率について説明する。

#### 【0028】図2に積層干渉層の断面図を、図3に積層

干渉層の反射率を示す。但し、各層の屈折率は前述した値であり、波長分散がないものとした。

【0029】図2は、透明基板1と積層干渉層11とから形成されており、その構成は、図1に示したものと同一である。

【0030】図3中、R(H)は石英基板上に高屈折率層を1層形成した時、R(HLH)は石英基板上に高屈折率層、低屈折率層、高屈折率層の3層を形成した時（図2で示す構成）、R(HLHLH)は高屈折率層と低屈折率層とを交互に5層積層したときの反射率を示している。

【0031】図3から分かるように、R(H)の場合には最大反射率は低く、また高反射率帯から低反射率帯へと変化する波長領域が広い。これに対し、R(HLH)の場合、すなわち、一対の高屈折率層の層間で多重反射が生じる場合、最大反射率は高まり、また高反射率帯から低反射率帯へと変化する波長領域が狭くなる。すなわち、屈折率変化の急峻性が増大する。これは、低屈折率層と高屈折率層の積層数が多くなるほど、すなわち多重反射する機会が多くなるほど顕著である（反射率の計算法については、「光学薄膜 H. A. Macleod著 小倉繁太郎他 訳 日刊工業新聞社」や、「光学薄膜 第2版 藤原史郎編 石黒浩三、池田英生、横田秀嗣著 共立出版」に記載）。

【0032】また、図1に示す構造の光記録媒体の積層干渉層の積層数を変えて計算した反射スペクトルを図4に示した。積層数が増加するにしたがって、最大反射率と最小反射率の差が大きくなり、かつ変化が急峻になっていることが分かる。この傾向は、図3と同様に、積層数が増加するにつれて、干渉効果が顕著に現れ、反射率変化の急峻性が増す。

【0033】次に、図1の超解像再生膜の屈折率が異なる場合の光記録媒体の反射率を図5に示す。図5に示すように、屈折率が増加するに伴い反射率が最小となる波長が長波長側にシフトする。

【0034】例えば、超解像再膜の屈折率が1.7から1.8に変化した場合、波長410nm付近での光の反射率差は約0.7程度まで変化する。

【0035】図5からも分かるように、この反射率差は、反射率変化が急峻であるほど大きくできる。

【0036】次に、超解像再生膜について説明する。

【0037】本発明に係る超解像再生膜は、所定の閾値以下の光に対して所定の屈折率（以下、初期の屈折率と呼ぶ）を有し、所定の閾値を超える光が照射された部分のみ、選択的に異なる屈折率（以下、超解像再生時の屈折率と呼ぶ）に変化する材料から形成される膜であり、一般にヒートモード系と、フォトンモード系のものが知られている。

【0038】ヒートモード系の超解像再生膜とは、光ビーム照射による加熱で閾値を超える部分のみを選択的に

相転移などを発生させ、屈折率を変化させる。例えばカルコゲン系のGeSbTe、AgInSbTeなどの相変化材料、ピアンスロン系、スピロビラン等のサーモクロミック材料などが挙げられる。

【0039】フォトンモード系の超解像再生膜は、例えばフォトクロミック材料など光照射により発色又は消色を利用したものが挙げられる。フォトクロミック材料は光照射より電子が規定順位から寿命の短い励起状態へ励起し、さらに励起順位から寿命の非常に長い準安定励起順位へ遷移して補足されることにより屈折率を選択的に変化させる。具体的には、ビロベンゾビラン系分子、フルギド系分子、ジアリールエテン系分子、シクロファン系分子、アゾベンゼンなどが挙げられる。また、吸収飽和により光学定数が変化する半導体、半導体微粒子分散膜などが挙げられる。

【0040】このような超解像再生膜には、閾値を超える光に対して高屈折率に変化するものと、低屈折率に変化するものとがあるが、ここでは前者の場合の超解像再生方法を説明する。

【0041】図6(a)にレーザで発信する光ビームの強度分布、(b)に光ビームの強度に対する超解像再生膜の屈折率変化を図示する。また(c)は、この超解像再生膜を図1に示す光記録媒体に用いた時の、光記録媒体の光学特性を示す平面図を示す。

【0042】光ビームは、一般に図6(a)に示すように強度分布を持ち、ビームの中心から離れるにしたがって、強度が弱まる。超解像再生膜は閾値を超える光ビームに対し、屈折率を初期の屈折率nからn<sub>1</sub>に変化させる。ここで、n=1.7、n=1.8、光ビームの波長が410nmの場合、図5に示すように屈折率1.7の位置では反射率が約2%であり、屈折率1.8の位置では反射率が約70%となる。

【0043】したがって、図6(c)に示すように光スポットSの中でも、屈折率が変化した領域のみ光を反射させ、初期の屈折率の位置では光を反射させない、すなわち、閾値を超える光照射部のみ光学開口部が形成され、この光学開口部に対応する範囲の記録情報を検出し、閾値以下の光照射部には光学マスク部が形成され、この光学マスクに対応する範囲の記録情報は検出されない。したがって、光スポットSよりも狭ピッチで記録情報の読み取り、すなわち超解像再生を可能にする。

【0044】また、初期の屈折率時の光記録媒体の値の調整は、超解像再生膜の膜厚を制御する方法に限らず、超解像再生膜に隣接して光学的マッチング層を形成し、超解像再生膜の初期の屈折率および膜厚に応じて、マッチング層の屈折率および膜厚を調整することでも可能である。

【0045】図5では、超解像再生膜の初期の屈折率が1.7の場合について説明したが、同様に初期の屈折率が2.3の場合について検討してみる。

【0046】超解像再生膜として初期の屈折率が2.3のものを用い、その膜厚を再生光波長410nmで光記録媒体の反射率が最低となるように73.5nmとしたことを除き図5の特性を示す光記録媒体と同様の構成の光記録媒体を用いた。

【0047】このような光記録媒体において、超解像再生膜の屈折率が閾値を超える光によって2.32、2.35あるいは2.4に変化する場合の光記録媒体の反射率を図7に、反射率差を図8に示す。

10 【0048】屈折率変化が0.02と小さくても光学開口と光学マスクの反射率差は10%を越えている。

【0049】また、図8より分かるように、反射率の変化量が最大となるのは410nmより少しずれた波長である。したがって、実際に再生波長で反射率差を最大とするためには、超解像再生膜を調整し、初期の屈折率のときに光記録媒体の反射率が最低になるようにすることが望ましい。

【0050】また、初期の屈折率時の光記録媒体の反射率の調整は、超解像再生膜の膜厚を制御する方法に限らず、超解像再生膜に隣接して光学的マッチング層を形成し、超解像再生膜の初期の屈折率及び膜厚に応じて、マッチング層の屈折率及び膜厚を調整することでも可能である。

20 【0051】これらの結果を、横軸に超解像再生膜初期の屈折率nに対する変化した屈折率n<sub>1</sub>の変化量△n(n-n<sub>1</sub>)の割合△n/n、超解像再生膜の膜厚をdとし、縦軸に単位膜厚当たりの反射率差△R/d(nm<sup>-1</sup>)として、初期の屈折率1.7と時を○、2.3の時を△、また積層干渉層を設けなかった場合を×として図9に示す。

【0052】△R/d > △n/n × 0.007なる関係を満たす時に積層干渉層を調整すると本発明の効果が顕著化することが分かる。つまり、超解像再生膜の屈折率変化量に応じて上述した関係を満たすように積層干渉層を調整する必要がある。具体的には、高屈折率層と低屈折率層のそれぞれの屈折率や積層数によって△Rを調整することができる。例えば、低屈折率層と高屈折率層の組合せを変化させると、図10に示すように最大反射率と最小反射率が変化する。

40 【0053】低屈折率層と高屈折率層の屈折率差が大きいほど、光記録媒体の最大反射率は高く、最小反射率は低くなり、反射率差が大きくなる傾向がある。最大反射率R<sub>max</sub>、最小反射率R<sub>min</sub>として、反射率差R<sub>max</sub>-R<sub>min</sub>と△R/dの関係を図11に示した。図11には、積層干渉層が配置されていない場合も併記する。

【0054】図11から分かるように、R<sub>max</sub>-R<sub>min</sub> > 0.2の範囲で急激に△R/dが増加し、積層干渉層を設けることの効果が顕著化する。したがって、積層干渉層として、△R/d > △n/n × 0.007な

る関係を満たし、かつ $R_{max} - R_{min} > 0.2$ を満たすことが好ましい。

【0055】なお、上述した屈折率とは複素屈折率の実部を指し、虚部の消衰係数を0として説明したが、超解像再生膜の消衰係数が0でない場合について述べる。図1と同様な構成の光記録媒体で、超解像再生膜の屈折率が2.3、消衰係数が0.0.1.0.2.0.5あるいは1の時の光記録媒体の反射率を図12に示す。但し、超解像再生膜の膜厚は、73.5nmとした。

【0056】図12より分かるように、消衰係数が大きくなるにつれて最大反射率 $R_{max}$ は低くなり、最小反射率 $R_{min}$ は高くなり、 $R_{max} - R_{min}$ は小さくなる。また、高反射領域から低反射領域への反射率の変化が緩慢になる。このため、この状況で仮に屈折率が変化しても、光学開口と光学マスクの反射率差はわずかであり、十分な効果が得られない。したがって、 $R_{max} - R_{min} > 0.2$ を満たす範囲であれば、超解像再生膜は有限の消衰係数を持っても、積層構造の効果を得ることができる。

【0057】本発明は、屈折率変化が消衰係数の変化に対して大きい場合に特にその効果が得られる。この場合は、最小反射率となる波長がシフトすることによる反射率変化が支配的となるため、屈折率前と変化後の反射率差は最小反射率となる波長の設定により正負を自由に選択することができる。

【0058】なお、上述の説明では、積層干渉層に用いられる高屈折率層あるいは低屈折率層は、それぞれ同一の屈折率を有するものであったが、本発明に係る高屈折率層、あるいは低屈折率層は、隣合う屈折率層に対して相対的な屈折率が高い、あるいは低いものであればよい。すなわち、第1の高屈折率層と第2の屈折率層との間で、入射光が多重反射する積層干渉層の構成を満たせばよい。

【0059】また、上述したような条件を満たすものであれば、積層干渉層、記録層および超解像再生膜の積層順を任意に設計できる。

【0060】さらに、図1においては、透明基板にピットを形成し、透明基板と記録層とを兼用したが、本発明に係る記録層は、これに限定されるものではなく、画像情報に応じて光学特性の異なる領域が形成された記録層を別途積層した構成とすることも可能である。

【0061】また、超解像再生膜として高屈折率の材料を用いることで、図1に示す超解像再生膜と隣接する高屈折率層を省略することができる。すなわち、超解像再生膜の初期の屈折率が、低屈折率層の屈折率よりも大きければ、超解像再生膜と高屈折率層との間で光の多重反射・多重干渉が生じるために、図1で示す光記録媒体と同様な効果が得られる。

【0062】

【実施例】以下、本発明の実施例を図面を参照して説明

する。

#### 【0063】実施例1

本実施例においては、透明基板/[低屈折率層/高屈折率層]×3/超解像膜/反射膜の積層構造の光記録媒体を用いた。なお[低屈折率層/高屈折率層]×3は、低屈折率層と高屈折率層が3組積層された積層干渉層である。

【0064】それぞれの層は、再生光が波長413nmの場合に超解像再生が行えるように、以下の通り調整した。

【0065】透明基板としてポリカーボネート(PC)基板を用い、このPC基板にはトラック別に0.2μm～0.6μmのピットがそれぞれ形成した。

【0066】低屈折率層及び高屈折率層には、SiO<sub>2</sub>(屈折率:1.5)およびZnS(屈折率:2.4)を用い、膜厚は光学膜厚が1/4に相当する膜厚、低屈折率層68.3nm、高屈折率層42.7nmとした。

【0067】屈折率:2.3、消衰係数は0の超解像再生膜を用い、その膜厚は、再生光が照射されていない初期状態において光記録媒体の反射率が最小となるように73.5nmとした。この超解像再生膜は再生光が照射されると光スポットの中心部のみ屈折率が2.4に変化する。

【0068】反射膜にはAlTiを用い、その膜厚は50nmである。

#### 【0069】比較例1

積層干渉層がない以外は、本実施例と同様の構成のディスクを作製した。

【0070】実施例1および比較例1のディスクをKr+ガスレーザーを光源とした再生評価機でCNR(Carrier to Noise Ratio)のピット長依存性を測定した。なお、再生波長413nm、再生パワー1mWである。

【0071】その結果を図13に示した。図13からわかるように、ピット長が0.4μm以上と長い場合は、超解像再生膜が無い比較例の方がCNRが大きいが、ピット長が0.4μmよりも短くなると急激にCNRが減少する。これは十分な超解像効果が得られていないためである。これに対し、本実施例のディスクはピット長が0.2μmと短くなても高いCNRを維持している。以上のことから、多層誘電体が超解像再生膜の特性向上に効果があることが確認できた。

#### 【0072】実施例2

本実施例においては、透明基板/[低屈折率層/高屈折率層]×2/低屈折率層/超解像膜/マッチング層/反射膜の積層構造の光記録媒体を用いた。なお、[低屈折率層/高屈折率層]×2は、低屈折率層と高屈折率層が2組積層された積層干渉層である。

【0073】再生光は実施例1と同様波長413nmのレーザーを使用した。

【0074】透明基板、低屈折率層、高屈折率層および反射膜については、材質、膜厚など実施例1と同じ条件とした。

【0075】超解像再生膜は、実施例1と同じ屈折率の材料を用いた。本実施例においては超解像再生膜の膜厚を光学膜厚が $\lambda/4$ に相当する膜厚、すなわち44.9 nmにした。

【0076】マッチング層にはAINを用いた。AINの屈折率は1.8である。マッチング層の膜厚は、再生光が照射されていない初期状態において反射率が最小となるように100nmとしてある。反射膜にはAlTiを用い、その膜厚は50nmである。

【0077】実施例1と同様の測定を行い、実施例1と同様の効果を確認した。

### 実施例3

本実施例の層構成は実施例1と同様の層構成である。但し、屈折率が2.2、消衰係数が0.4の超解像再生膜を用いた。この超解像再生膜は再生光の照射により、再生光のスポット中心部のみ屈折率が2.15、消衰係数が0.05に変化する。

【0078】実施例1と同様の測定を行い、同様の効果を確認した。

### 【0079】実施例4

本実施例においては、透明基板/[低屈折率層/高屈折率層]×3/超解像再生膜/マッチング層/記録層/保護層/反射層の積層構造の光記録媒体を用いた。

【0080】それぞれの層は、再生光が波長413nmの場合に超解像再生が行えるように、以下の通り調整した。

【0081】高屈折率層、低屈折率層、超解像再生膜、マッチング層、反射膜については実施例2と同様にし、透明基板には記録ビットを形成せずに、Ge2Sb2Te5からなる膜厚20nmの相変化型材料を記録層として別途設け、また保護層として膜厚40nmのZnSSiO2層を形成した。

### 【0082】比較例2

積層干渉層を高屈折率層および低屈折率層を形成しない点を除き実施例4と同じ光記録媒体を作成した。

【0083】実施例4および比較例2で得られた光記録媒体に以下の要領で記録、再生を行った。

【0084】記録・再生波長を413nmのレーザーで行い、6m/sでこのレーザーを走査して記録、再生を行った。記録光は9mWとし、マーク長0.3μmの記録マークをマーク間隔を変化させながら單一周波数で記録した。

【0085】この記録情報の再生を、再生パワー1mWに設定して行った。その結果を図14に示す。

【0086】図14から分かるように、マーク間隔が0.3μm以下の時に、比較例2の光記録媒体では符号

間干渉の影響が強いためにCNRが低下している。また、隣接トラックからのクロストークも大きいためにトラック上のマーク間隔が長い場合でもCNRの値は大きくならない。

【0087】これに対し、実施例4の光記録媒体においてはマーク間隔が0.15μmでも高いCNRで再生できる。またクロストークの影響を受けないために、マーク間隔が0.3μmを超える領域でも比較例2の光記録媒体よりもCNRよりも大きくできている。

### 【0088】

【発明の効果】上述したように、本発明によれば超解像再生膜を有する光記録媒体の、光学マスク部と、光学開口部の光反射率差を大きくすることができるため、狭マークピッチ、狭トラックピッチの記録マークを高分解能で再生することが可能となる。

#### 【図面の簡単な説明】

【図1】 本発明の光記録媒体の一例を示す断面図。

【図2】 積層干渉層の断面図。

【図3】 積層干渉層の反射率。

【図4】 積層干渉層の積層数が変化した時の光記録媒体の反射率を示す図。

【図5】 図1の超解像再生膜の屈折率が変化した場合の光記録媒体の反射率変化を示す図。

【図6】 (a)は光ビームの強度分布、(b)は光ビームの強度に対する超解像再生膜の屈折率変化、(c)はこの超解像再生膜を光記録媒体に用いた時の、光記録媒体の光学特性を示す平面図を示す。

【図7】 本発明の別の実施形態の光記録媒体における光記録媒体の反射率変化を示す図。

【図8】 図6に示す反射率変化から求めた反射率差を示す図。

【図9】 超解像再生膜の屈折率変化量と膜厚当たりの反射率差の関係を示す図。

【図10】 積層干渉層を構成する層の屈折率の違いによる最大反射率および最小反射率の変化を示す図。

【図11】 超解像再生膜の屈折率変化および膜厚と、最大反射率および最小反射率との関係を示す図。

【図12】 消衰係数が0でない場合の光記録媒体の反射率を示す図。

【図13】 本実施例1における光記録媒体におけるCNRのビット長依存性を示す図。

【図14】 本実施例4の光記録媒体におけるCNRのマーク長依存性を示す図。

#### 【符号の説明】

1…透明基板

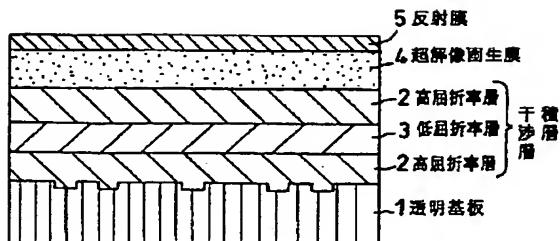
2…高屈折率層

3…低屈折率層

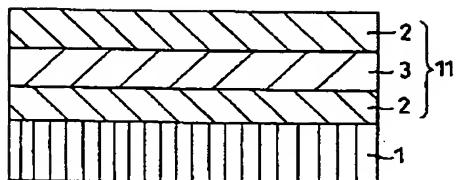
4…超解像再生膜

5…反射膜

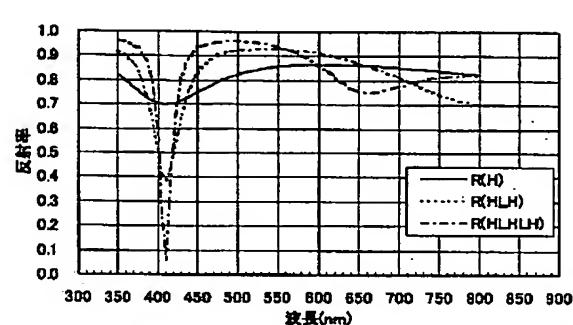
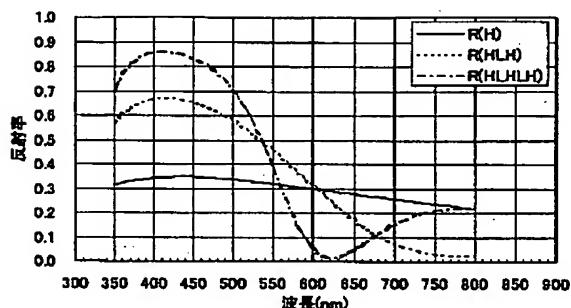
【図1】



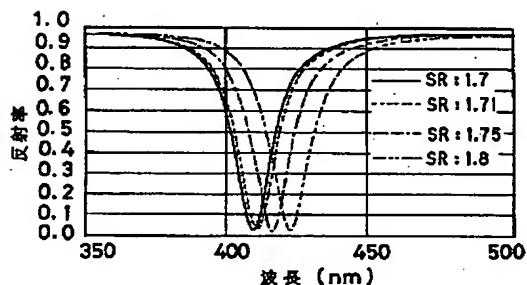
【図2】



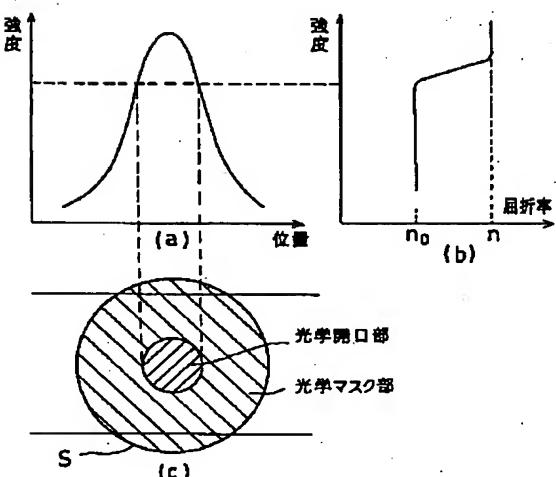
【図3】



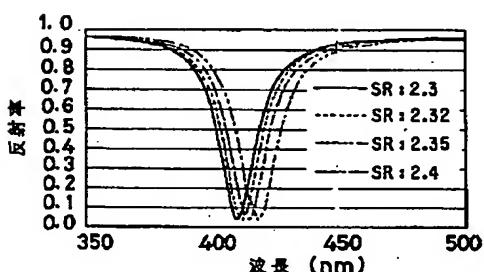
【図5】



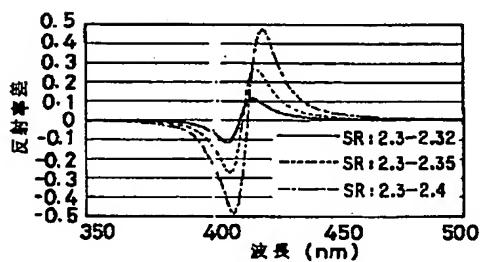
【図6】



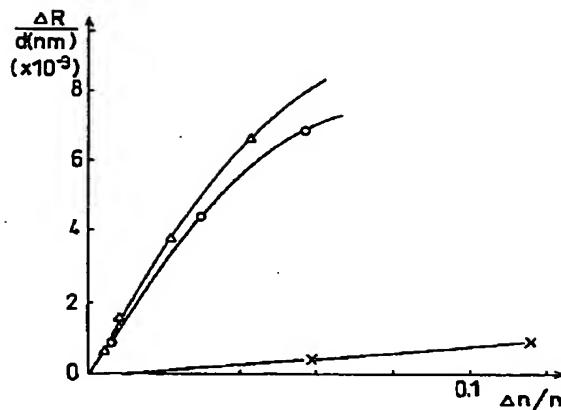
【図7】



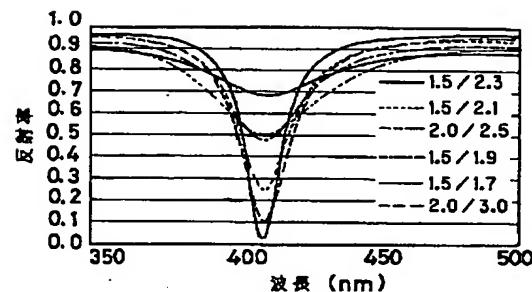
【図8】



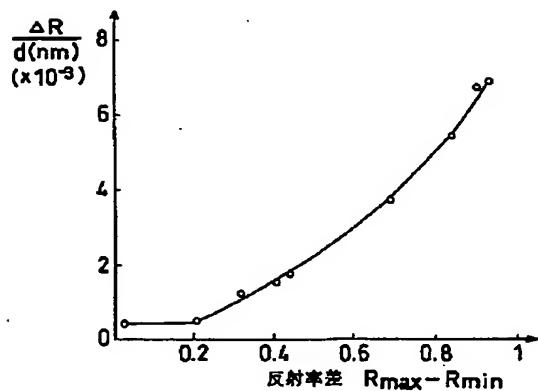
【図9】



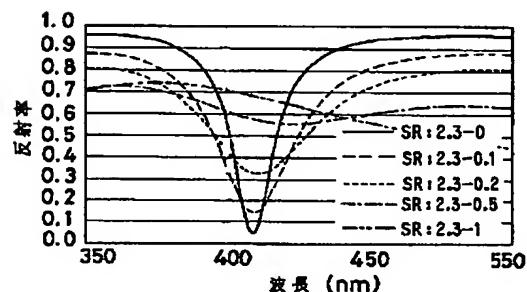
【図10】



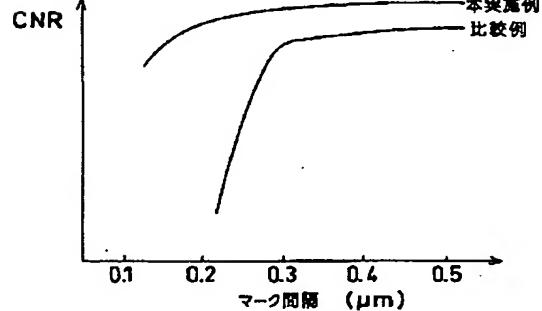
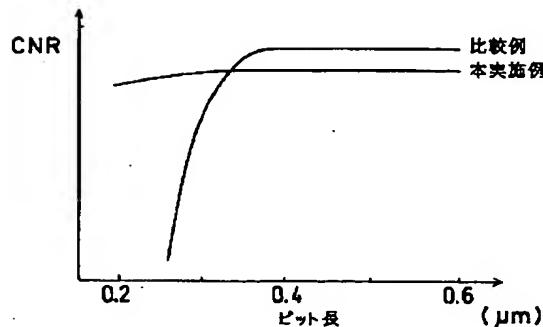
【図11】



【図12】



【図13】



フロントページの続き

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